Claims

1. A method of making a heat exchanger comprising the steps of:
providing a header defining openings having an inner surface, said header openings adapted to receive a plurality of tubes having outer surfaces;
inserting said tubes into said header openings such that said inner surfaces of said header openings and said outer surfaces of said tubes are adjacent to each other;
applying substantially uncured fluid sealing material to at least said inner surfaces of said header openings such that said inner surfaces of said header openings and said outer surfaces of said tubes are connected by said sealing material; and
curing said sealing material after said tubes are inserted into said header openings, said sealing material providing a flexible, bonded, liquid tight, tube-to-header joint.

2. The method of claim 1 wherein said sealing material is an elastomer.

3. The method of claim 1 wherein said sealing material is being cured by vulcanization.

4. The method of claim 1 wherein said sealing material is applied to said outer surface of said tubes.

5. The method of claim 1 wherein said sealing material is a liquid.

6. The method of claim 1 wherein said inner surface of said header opening and said outer surface of said tubes frictionally fit.

7. The method of claim 1 wherein the step of curing said sealing material includes room temperature vulcanization.

8. The method of claim 7 wherein said curing uses ultraviolet light.

9. The method of claim 1 wherein in the step of inserting said tubes a gap is defined by said inner surfaces of said header openings and said outer surfaces of said tubes, and said fluid sealing material is applied in said gap.

10. The method of claim 1 wherein said sealing material is essentially uncompressed after said curing.

11. The method of claim 1 further comprising after the step of inserting said tubes, adding the step of providing a tank having an inner cavity and said tank defining an opening adapted to receive said tubes, said tank being attached to or integral with said header such that said tubes extend through said tank opening and open ends of said tubes communicate with said tank inner cavity.

12. A method of making a heat exchanger comprising the steps of:

providing a header defining openings, said header openings adapted to receive a plurality of tubes;

providing a tank having an inner cavity and said tank defining an opening adapted to receive said tubes, said tank being attached to or integral with said header;

inserting said tubes into said header openings and fixedly attaching said tubes to said header such that said tubes extend through said header openings and open ends of said tubes communicate with said tank inner cavity;

applying substantially uncured fluid sealing material between said tank and said header defining a joint such that said header and said tank are connected by said sealing material; and

curing said sealing material of said joint such that said sealing material provides a flexible, bonded, liquid tight, header-tank joint.

13. The method of claim 12 wherein said tubes are attached to said header by brazing.

14. A method of making a heat exchanger comprising the steps of:

providing a header defining openings having inner surfaces, said header openings adapted to receive a plurality of tubes having outer surfaces;

applying substantially uncured fluid sealing material to at least said inner surfaces of said header openings;

curing said sealing material before said tubes are inserted into said header openings, said sealing material providing elastomeric members bonded to said inner surfaces of said header openings adapted to receive said tubes; and

inserting said tubes into said header openings such that said inner surfaces of said header openings and said outer surfaces of said tubes are adjacent to each other and are connected by said elastomeric members to provide a flexible, liquid tight, tube-to-header joint.

15. The method of claim 14 wherein said elastomeric members are compressed by said tubes to provide a flexible, liquid tight, tube-to-header joint.

16. The method of claim 14 wherein an inside dimension of said elastomeric members is determined during curing using a mandrel.

17. The method of claim 14 wherein in the step of curing said sealing material includes room temperature vulcanization.

18. The method of claim 14 wherein in the step of curing said sealing material includes ultraviolet light.

19. The method of claim 14 wherein said elastomeric member includes an internal dimension being defined and formed using a Teflon mandrel, said internal dimension being less than an outer dimension of said tube providing a compression sealing fit between said elastomeric member and said tube.

20. A method of making a heat exchanger comprising the steps of:

providing a header defining openings having an inner surface;

providing a plurality of grommets defining openings having inner surfaces and adapted to receive a plurality of tubes, and said grommets adapted to fit into said openings in said header;

inserting said tubes into said grommet openings such that said inner surfaces of said grommet openings and outer surfaces of said tubes are adjacent to each other;

applying substantially un-cured sealing material to at least said inner surfaces of said grommets openings such that said inner surfaces of said openings of said grommets and said outer surfaces of said tubes are connected by said sealing material; and

curing said sealing material after said tubes are inserted into said grommet openings, said sealing material providing a flexible, bonded, liquid tight, tube-to-grommet joint.

21. The method of claim 20 wherein said grommet is bonded to said header.

22. The method of claim 20 wherein said grommet is bonded to both said header and said tube outer surface.

23. The method of claim 20 wherein said grommet comprises a cured silicone rubber.

24. The method of claim 20 further comprising after the step of inserting said tubes the step of providing a tank having an inner cavity and said tank defining an opening adapted to receive said tubes, said tank being attached to or integral with said header such that said tubes extend through said grommets and said tank opening, and open ends of said tubes communicate with said tank inner cavity.

25. The method of claim 24 wherein said outer surfaces of said tubes are attached to said header to form a tube-to-header joint, and said tank and said header are attached by a flexible bond providing a tank-to-header joint adapted to accommodate thermal expansion of said tubes.

26. The method of claim 24 wherein said tank-to-header joint includes a silicone adhesive.

27. The method of claim 24 wherein said tube-to-header joint is substantially rigid.

28. A method of making a heat exchanger comprising the steps of:

providing a header defining openings having an inner surface, said header openings adapted to receive a plurality of tubes having outer surfaces;

providing a structure defining openings, said structure openings having an inner surface and adapted to receive said plurality of tubes, said structure openings being aligned with said header openings to mutually receive said plurality of tubes;

providing a sealant member having at least one bonding surface, said sealant member being positioned between said structure and said header such that said sealant member is adjacent to said outer surfaces of said tubes;

inserting said tubes into said header openings such that said inner surface of said header openings, said inner surface of said structure openings, and said bonding surface of said sealant member are adjacent to each other;

compressing said sealant member between said structure and said header such that said header and said tubes are connected by said bonding surface of said sealant member; and

curing said sealant member after said tubes are inserted into said header openings, said sealant member providing a flexible, bonded, liquid tight, tube-to-header joint.

29. The method of claim 28 wherein said sealant member includes silicone.

30. The method of claim 28 wherein the sealant member includes a specified amount of silicone.

31. The method of claim 28 wherein said sealant member includes a first portion being of uncured silicone and a second portion of cured silicone, said first portion being positioned toward said header and said tube outer surface such that said first portion is touching said tube outer surface and said header after said sealant member is compressed, and said step of curing said sealant member being applied to said uncured silicone of said first portion of said sealant member.

32. The method of claim 28 after the step of providing a header further comprising the steps of providing a plurality of grommets defining openings having inner surfaces and adapted to receive said plurality of tubes, and said grommets adapted to fit into said openings in said header; and
in said step of inserting said tubes into said header openings, inserting said tubes into said grommets in said header openings.

33. The method of claim 32 wherein in said step of curing said sealant member said grommets are bonded to both said tubes and said header.

34. A heat exchanger which comprises:

a plurality of tubes having predetermined dimensions, said tubes including an outer surface and being open at one end;

a header structure defining a plurality of openings, said openings being adapted to receive said tubes; and

a plurality of elastomeric sealing joints being positioned between said outer surface of said tubes and said header, and said sealing joints being bonded to said outer surface of said tubes and said header.

35. The heat exchanger according to claim 34 further comprising a tank being integral with said header.

36. The heat exchanger according to claim 34 wherein said sealing joint comprises a silicone bonding material.

37. A heat exchanger which comprises:

a header defining openings having inner surfaces, said header openings adapted to receive a plurality of tubes, and said tubes being inserted through said header openings; and

a cured-in-place seal between said tubes and said header, said seal being bonded to said header, and said seal providing an elastomeric compression sealing fit between said tube and said seal.

38. The heat exchanger according to claim 37 further comprising a tank integral with said header.

39. The heat exchanger according to claim 37 wherein said cured-in-place seal includes an internal dimension smaller than an outer dimension of said tubes to provide said compression sealing fit between said tubes and said cured-in-place seal.

40. The heat exchanger according to claim 39 wherein said internal dimensions of said cured-in-place seal is formed using a Teflon™ mandrel.

41. A heat exchanger which comprises:
a header defining openings, said header openings adapted to receive a plurality of tubes, and said tubes being inserted through said header openings; and
a cured-in-place seal between said tubes and said header, said seal being bonded to said tube, and said seal providing an elastomeric compression sealing fit between said header and said seal.

42. The heat exchanger according to claim 41 further comprising a tank being integral with said header.

43. The heat exchanger according to claim 41 wherein said cured-in-place seal comprises silicone.

44. A heat exchanger which comprises:
a plurality of tubes having predetermined dimensions, said tubes including an outer surface and being open at one end;
a header structure defining a plurality of openings, said openings being adapted to receive said tubes; and
a tank being positioned above said header structure and having openings being adapted to receive said tubes, a sealing member including silicone bonding material which bonds said tubes to said header.

45. The heat exchanger according to claim 44 wherein said header is integral with said tank.

46. The heat exchanger of claim 44 wherein said gap is defined by an extended surface area of said header and said tank, said tubes intersect said surface area and

traverse said gap, and said sealing member includes a bond between said tank, said header, and said tubes.

47. The heat exchanger according to claim 44 wherein said sealing member comprises a silicone bonding material.

48. A heat exchanger which comprises:

a plurality of tubes having predetermined dimensions, said tubes including an outer surface and being open at one end;

a header structure defining a plurality of openings, said openings being adapted to receive said tubes;

a plurality of elastomeric grommets being positioned circumferentially about said outer surface of said tubes, said grommets having at least one bonding portion of sealing material adjacent to said tubes and said header; and

a plurality of sealing joints including said sealing material of said grommet bonded to said header and said tube.

49. The heat exchanger according to claim 48 wherein said sealing joint comprises a silicone bonding material.

50. A heat exchanger which comprises.

a plurality of tubes having predetermined dimensions, said tubes including an outer surface and being open at one end;

a header structure defining a plurality of openings, said openings being adapted to receive said tubes, and said tubes being fixedly attached to said header structure;

a tank being positioned above said header structure and having openings being adapted to receive said tubes, said tank and said header structure defining a gap between said header structure and said tank, and said gap being adapted to receive bonding material; and

a sealing member including cured said bonding material which forms a flexible bond between said tank and said header.

51. The heat exchanger of claim 50 wherein said tubes are fixedly attached to said header structure by brazing.